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Electrical property mapping of ZnO:Al films with micro four-point-probe technique

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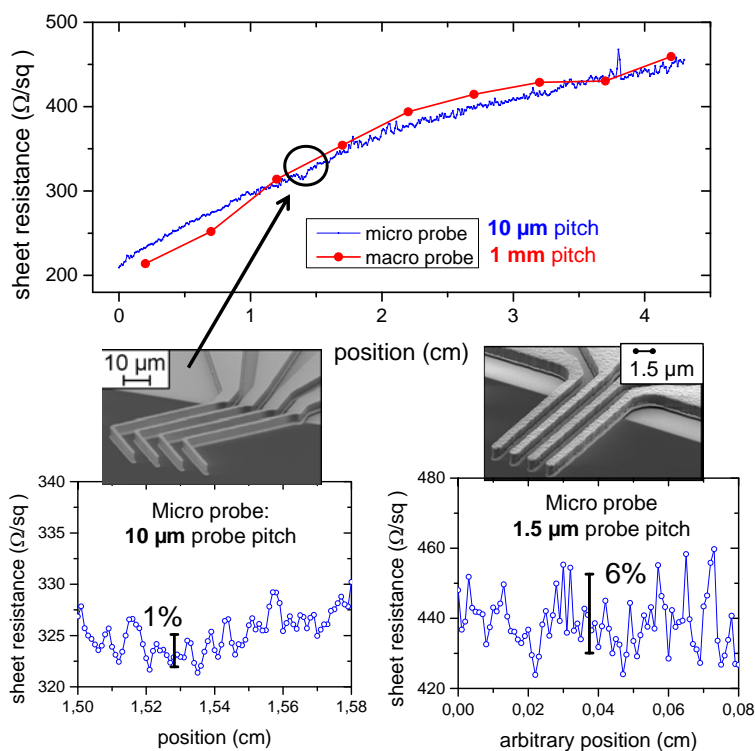
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Motivation

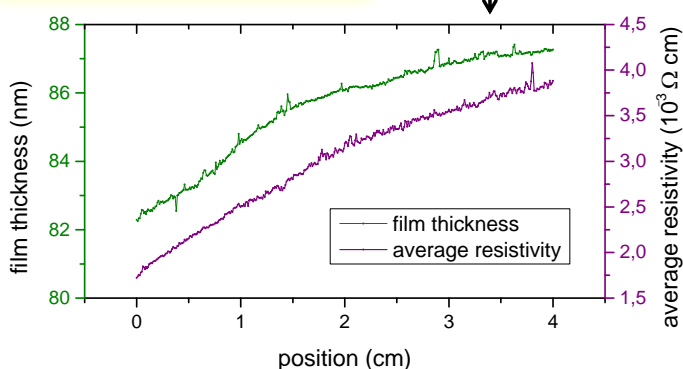
Demonstrating the advantages of a **micro-four-point probe** setup for mapping electrical properties of transparent conductive films:

1. High spatial resolution
2. Non-destructive
3. Compatible with in-line processes
4. No sample preparation for Hall measurement
5. Error suppression by combining measurements from 7 probes

Sheet resistance measurement



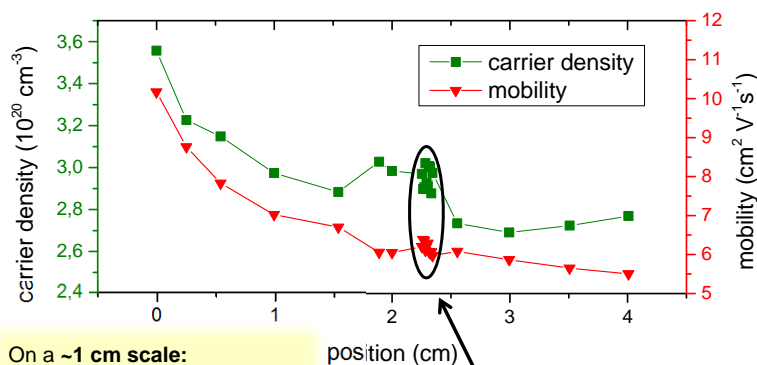
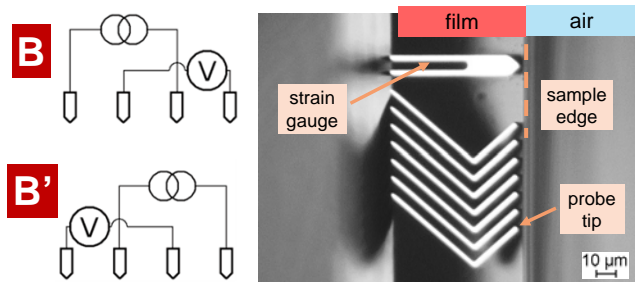
Probe with smaller pitch is more sensitive to local variations and reduces correlation effects



Hall measurement

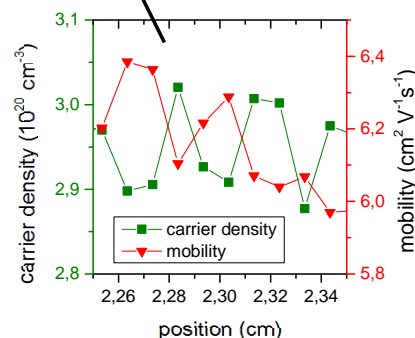
measure V_B and V_B' close to an insulating boundary

determine Hall mobility and carrier density



On a $\sim 1 \text{ cm}$ scale:
Resistivity decreases due to increase in both carrier density and mobility

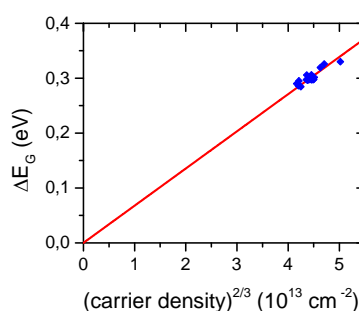
On a $\sim 100 \mu\text{m}$ scale:
carrier density and mobility vary in antiphase (measurement noise)



thickness

optical mapping (ellipsometry)

band gap



Burstein-Moss effect mapping:

$$\Delta E_G = \text{const} \left(\frac{1}{m_c} + \frac{1}{m_v} \right) n^{2/3}$$

ΔE_G : (optical band gap of ZnO:Al) – (band gap of undoped ZnO)

n : carrier density

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